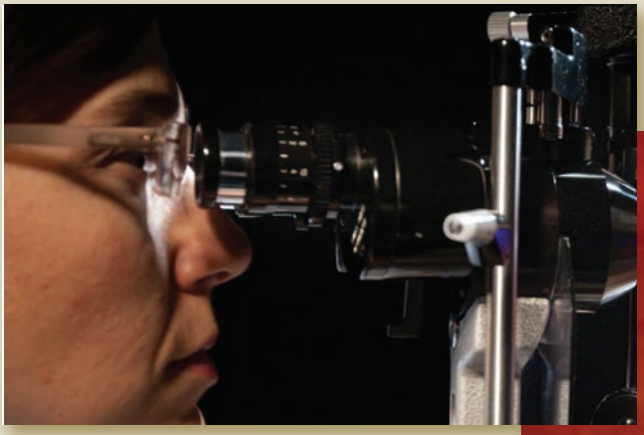
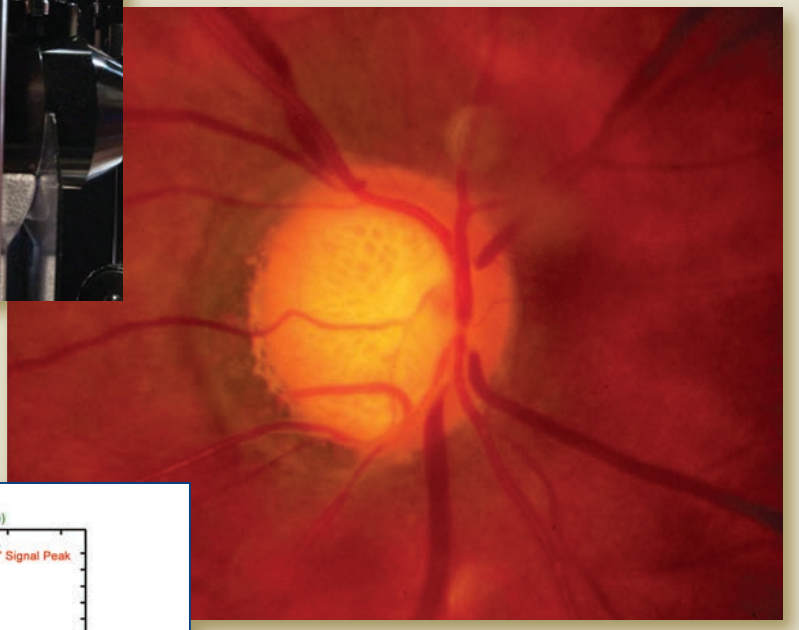
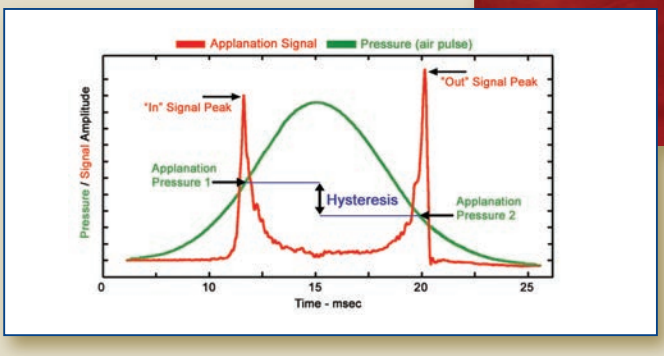
OPTOMETRIC Management
FEBRUARY 2012

Using Biomechanics to Advance Glaucoma Care

A panel of experts discusses how affordable new technology expands screening, diagnosis and monitoring of glaucoma.

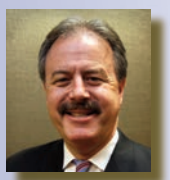






Ben Gaddie, OD, FAAO, (moderator) practices at the Gaddie Eye Centers in Louisville, Kentucky, where he focuses on primary care, including many glaucoma patients. He is vice president of the Optometric Glaucoma Society and president of the Kentucky Optometric Association.

Marc Bloomenstein, OD, FAAO, practices at the Schwartz Laser Eye Center in Scottsdale, Arizona. The practice focuses on cataract and refractive surgeries.



Jim Thimons, OD, FAAO, is the Optometric Medical Director for Ophthalmic Consultants of Connecticut. The practice is a consultative specialty practice that serves Connecticut, Rhode Island and the New York City region. He is chairman of the National Glaucoma Society and a former president of the Connecticut Optometric Association.

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Using Biomechanics to Advance Glaucoma Care

A panel of experts discusses how affordable new technology expands screening, diagnosis and monitoring of glaucoma.

Dr. Gaddie: I have a special interest in the importance of corneal biomechanics, primarily in the context of glaucoma. We've gathered a panel of experts to discuss this topic and the Ocular Response Analyzer (ORA) from Reichert. This instrument provides us with several valuable metrics that we can use to measure biomechanics.

Understanding Biomechanics

Dr. Gaddie: Corneal biomechanics was proposed in 1992 as a means of assessing long-term stability and predictability of refractive procedures. Procedures and principles associated with mechanical engineering were used to provide valuable insight into the biomechanics of the cornea, allowing us to predict corneal behavior.[1]

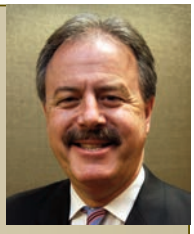
The relevance of these properties to glaucoma emerged with completion of the Ocular Hypertension Treatment Study (OHTS) in 2002, when we learned more about risk associated with glaucoma.[2] Dr. Wooldridge can share some insights gained from OHTS.

Dr. Wooldridge: The first report of the OHTS results revealed the benefit of decreasing pressure before the development of visible nerve damage or visual field loss. Using a modest treatment goal of reducing intraocular pressure (IOP) by 20%, risk of damage was reduced by more than 50%.[3] The more interesting part of the study, I thought, involved the study of risk factors. Some factors previously believed to increase risk of damage, such as diabetes, did not do so.[2]

Other factors, such as corneal thickness, were found to be very significant predictors of risk of damage. In fact, central corneal thickness was found to be the greatest risk factor in the OHTS.[2] Before 2002, most of us weren't checking corneal thickness and considering it when evaluating glaucoma suspects — those patients who had high IOP but no damage. Since the OHTS, corneal thickness has been the focus of a great deal of research and communication.[4-8]

A Goldmann applanation tonometry (GAT) reading can be significantly different from true IOP, depending on a patient's central corneal thickness (CCT).[9] A cornea that is thicker than normal requires a greater flattening force during GAT, resulting in an inflated estimate of IOP. A cornea that is thinner than normal can be flattened more easily, producing a low estimate of IOP.

> "I personally put corneal thickness into a risk pool that includes thin, moderate and thick corneas. These designations reflect a general characteristic of the patient as opposed to a specific nomogram used to interpret data."
>
> ***— Jim Thimons, OD, FAAO***



Dr. Gaddie: Let me ask a question in the context of the cornea and IOP. How many of you consider IOP based on pachymetry? For example, when you have an IOP of 26 mm Hg in a patient with a very thick cornea, do you interpret that as an IOP reading that's likely to be closer to 20 mm Hg?

Dr. Thimons: Some researchers and clinicians have tried to extract different types of information from the OHTS, including the use of corneal thickness to calculate a corrected IOP.[8,10] However, most practitioners now understand that the relationship

Using the ORA for Refractive Surgery and Corneal Care

Dr. Gaddie: How is ORA relevant in diagnosing keratoconus and for decision making in refractive surgery?

Dr. Bloomenstein: I have a great deal of experience with keratoconus patients, especially those with asymmetric corneas. Instead of a nice clean ORA signal pattern, you will see low and noisy peaks. Almost universally, the corneal hysteresis (CH) and corneal resistance factor (CRF) are lower than normal.

In refractive surgery — whether it's radial keratotomy, LASIK or photorefractive keratotomy (PRK) — we're thinning the cornea and/or changing its curvature. The vast majority of patients do very well after surgery, but we have some patients who develop ectasia despite normal pre-operative thickness and topography.

The biomechanics of the cornea have always raised an important question. How can we better identify a patient that might experience a bad result before the patient undergoes refractive surgery? Although modern topography systems have made those decisions much clearer, I don't think any one test can provide a definitive metric.

CH and CRF are low in keratoconus and significantly reduced in post-operative LASIK patients. We always look at the ORA pre-operatively. We consider topography, CCT, the magnitude of the prescription and the hysteresis value. If the CH value isn't normal, it raises a red flag. If we see any other reasons for concern, the patient becomes a PRK candidate or possibly not even a candidate for refractive surgery. It's the proverbial needle in a haystack. We don't see a tremendous amount of ectasia, fortunately, but at the same time, all it takes is one case. If using this technology can help us to prevent one patient from experiencing a significant sight-threatening complication, then it's worth its weight in gold.

We advise patients when everything looks normal, but we also educate them on this new test. We can turn to other options to meet their needs. Today, changing the shape of the cornea is not the only refractive procedure available, so we educate patients on all possibilities, as needed.

Dr. Thimons: When we installed the ORA, everyone in the office, including me, underwent the test, simply to understand it better and to be able to explain it to patients. I found that I had a particularly low CH value in my left eye and some abnormal signal characteristics. My right eye was normal.

Out of curiosity, I conducted a Pentacam (Oculus) scan, which I had never needed to undergo previously. We found that my left cornea is clearly forme fruste and my right cornea is normal. The ORA had detected the abnormality very accurately. I was quite impressed that a new technology so rapidly discovered a latent problem that had been present my entire career. As a result, I've become a firm believer in the use of this technology for corneal care.

between CCT and IOP isn't strong enough for accurate "correction" of IOP in individual patients. Actually, the correlation is weak and, in fact, non-linear.[11-13]

There is a significant probability that you'll "correct" the pressure in the wrong direction. I personally put corneal thickness into a risk pool that includes thin, moderate and thick corneas. These designations reflect a general characteristic of the patient as opposed to a specific nomogram used to interpret data.

Implications of Refractive Surgery

Dr. Bloomenstein: In making their calculations, the creators of the Goldmann tonometer assumed an average corneal thickness of 520 µm.[9] In our practice, where the primary focus is on refractive surgery, the measurement of corneal thickness has been standard of care. Thickness has always been a parameter for assessing risk involved in refractive surgery.[14] (See "Using the ORA for Refractive Surgery and Corneal Care" above.) What's interesting is that the standard deviation is up to 35 µm thicker and thinner than the average cornea. In most patients, you're not going to find 520 µm. To me, GAT has always been questionable. Also, because I see many pre- and post-op refractive surgery patients, I've always wondered how affecting the shape of the cornea translates to disease diagnosis. Regardless of whether we're flattening or steepening the cornea, we're certainly altering its thickness and curvature.

In a post-operative patient, I wonder how many millimeters of mercury we're off when we measure IOP with a Goldmann tonometer. How much further away are we from really knowing the pressure in these patients?

Dr. Gaddie: Dr. Thimons, what's the effect on IOP that you see after LASIK?

Dr. Thimons: We've performed about 60,000 cases at this juncture. Our general conclusion is that you can't really use GAT to measure IOP in a post-operative LASIK patient. The numbers vary considerably. There has to be another factor involved besides CCT measurements, which we've found we can't use to create nomograms. Corneal biomechanics has always been a large factor, which is why we've found the ORA to be so important in clinical practice. It gives us the ability to assess biomechanics. The ORA uses a rapid air impulse and an advanced electro-optical system to record two applanation pressure measurements; one measurement while the cornea is moving inward, and another measurement as the cornea returns.

Because of its biomechanical properties, the cornea resists the air puff, causing delays in the inward and outward applanation events, resulting in two different pressure values.

The average of these two pressure values provides a repeatable, Goldmann-correlated IOP measurement (IOPg). Meanwhile, the difference between the inward and outward applanation measurements provides us with a corneal hysteresis (CH) measurement. CH is a measurement of corneal tissue properties that results from viscous damping in the corneal tissue. This measurement provides us with information related to the biomechanical properties of the cornea.

The CH measurement also permits the device to provide a corneal-compensated IOP measurement referred to as IOPcc. IOPcc is less affected by corneal properties than other methods of tonometry, such as GAT.

Corneal Dystrophies

Dr. Gaddie: With these factors in mind, let's focus on corneal dystrophies and situations in which biomechanics are a factor. Consider these scenarios:

- A patient with Fuchs' dystrophy presents with the typical thick cornea, as measured by pachymetry.
- Another patient, by contrast, has keratoconus, with classic thinning of the cornea. How might these factors affect IOP?

> "We need to think of the ORA as being more than just a tonometer. This instrument provides information that goes far beyond the corrected pressure in the eye. The data tells us something about the basic biomechanics of the cornea as it relates to glaucoma progression and other issues."
>
> ***— Rob Wooldridge, OD, FAAO***

Dr. Wooldridge: These are great examples that drive home the point that all corneas are not the same. A young, healthy cornea that is 600 µm thick is not the same as the cornea of an older patient with a great deal of guttata and the same thickness. The Fuchs' cornea may be thick, but it's also floppy and weak, causing the GAT-measured IOP to be understated. I also think IOP in keratoconus is represented by GAT as being lower than the actual level. We have to look beyond corneal thickness, which is an oversimplification of the biomechanical properties of the cornea as they relate to IOP measurement.

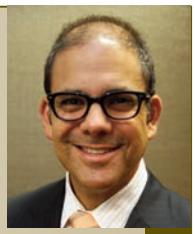
Variability of GAT

Dr. Bloomenstein: Another issue beyond accuracy in these abnormal corneas is the variability of GAT that is seen in all patients. We all work with students, technicians and other clinicians. Taking a pressure with GAT isn't easy. You may have too much or too little fluorescein in the eye, thus giving false high and low readings. There are so many factors that affect GAT measurements, we really need a simplified, less cumbersome, more reliable measurement.

Dr. Gaddie: You make a good point. I would guess that if the four of us had a patient here and we measured his IOP, we'd find consistent differences among our findings. The conundrum we find ourselves in today is that everything we do in glaucoma that's associated with treatment revolves around lowering IOP.[3,15] We're using a very inaccurate, if not completely inconsistent, device to measure it.

Dr. Wooldridge: Think about the advanced technologies we use today, yet we're still relying on Goldmann tonometry, a 60-year-old test. Unfortunately, the standard of care changes very slowly. We need to help people understand how poorly the Goldmann performs. We have better technology available today.

> The ORA provides that extra piece of the puzzle to help me make a diagnostic decision for the patient who has high pressure but otherwise normal examination findings and test results.
>
> ***— Marc Bloomenstein, OD, FAAO***



Close-up on Corneal Biomechanics

Dr. Gaddie: I think one of the highlights from the OHTS was that statistically thin corneal pachymetry, in the setting of ocular hypertension, was identified as an independent risk factor for conversion to glaucoma.[2] The cornea is reflecting glaucoma susceptibility. I'd like to get away from discussing corneal thickness and focus more on corneal biomechanics, both from a scientific standpoint and a clinical standpoint. My question is how do we measure corneal biomechanical properties such as corneal hysteresis?

Dr. Thimons: Clinicians and researchers have discussed corneal biomechanics for several years, but we haven't been able to learn much because no tool was available to measure these properties. I think the ORA is an instrument that's shown itself to be very capable of meeting this objective.[16]

Dr. Gaddie: Would anyone like to define corneal hysteresis (CH) to help advance this discussion?

Dr. Bloomenstein: CH is, quite simply, a value obtained by the ORA. As Dr. Thimons mentioned earlier, it's a value that's very important because the cornea is made of material that's not very well understood. It consists of complex viscoelastic tissue, with properties that are similar to a foam mattress. When you indent the cornea rapidly, it absorbs some of the energy of the indentation. The reaction of the material doesn't directly respond to the applied force. There's a delayed effect. The ORA measures this reaction, representing the hysteresis value. CH isn't a property, but a measurement output that represents the biomechanical properties of the cornea.

Dr. Gaddie: What do we know about CH from the literature?

Dr. Wooldridge: In general, we know that CH represents an aspect of corneal biomechanics, it's somewhat correlated to thickness and is found to be lower in patients with keratoconus[17] and Fuchs' dystrophy.[18] It's also reduced after ablative refractive surgery and, perhaps, most relevant to this discussion, it is lower in glaucoma patients — particularity in patients with significant progression.[19]

Dr. Thimons: One of the factors that I believe makes CH so interesting is that it seems to be associated with the structural integrity of the lamina cribosa. We tried to make that association with corneal thickness, but I don't think the correlation was highly relevant.

I think CH represents the whole eye, suggesting that the relationship between glaucoma and corneal thickness/corneal biomechanics is complex. CH seems to represent an indirect measurement of the integrity and strength of the lamina cribosa. Beyond a representation of corneal biomechanics, it's also a biomarker for glaucoma susceptibility.

Applying Hysteresis to Practice

Dr. Gaddie: I've found that CH is predictive of which patients with ocular hypertension are more likely to convert to glaucoma. Also, those patients who have been diagnosed with glaucoma and have low hysteresis are more likely to be quick progressors. I've found CH to be remarkably predictive of both of those situations.

Now, let's consider a clinical scenario in which a patient is identified as a glaucoma suspect and all the other typical test findings — cup-to-disc ratio, visual field, retinal nerve fiber layer — are equivocal for glaucoma. Have any of you reached the point when you look at CH and say, "This is the one factor that has motivated me to start treatment?"

Dr. Wooldridge: In such cases, I never treat on the basis of one finding alone, and I suspect you don't, either. However, I think CH is an important issue in a list of risk factors that we need to consider, recognizing the importance of the information in our decision-making.

Dr. Bloomenstein: Low CH is extremely predictive, indicating that something is going on, such as glaucoma, keratoconus or Fuchs' dystrophy. This is almost like seeing early tendencies in a child. The lower CH just implies that we should seek the diagnostic condition that is affecting the patient.

COST ANALYSIS

According to some surveys, for example, the technology survey published annually by *Review of Optometry,* the average optometrist is willing to spend $35,000 to $50,000 for a new piece of equipment in any given year. The ORA costs about $15,000.

While many doctors make equipment purchase decisions based on the anticipated return-on-investment, that can't be the only factor considered.

Doctors don't get paid for using autorefractors prior to the final refraction, and certainly these instruments are of significant value in terms of efficiency in patient care. Use of the ORA is reimbursable using CPT code 0181T, but since it's a category III code, getting reimbursed is not guaranteed and may take significant effort. But aside from reimbursement, there is tremendous value in giving the clinician a more accurate assessment of the IOP and information about the corneal biomechanics of the patient.

Another consideration is that Reichert has a simplified version of the ORA called the 7CR, which essentially measures just the IOPcc. The IOPcc is clearly valuable — and for doctors who just want a device that measures pressure more accurately, the 7CR is slightly simpler and less expensive than the ORA.

Dr. Gaddie: I agree. In my practice, if someone has normal cup-to-disc ratio, no family history and normal IOP, and I see that the CH is low, I interpret that finding as being noncontributory to the patient's examination. However, I've seen how predictive low CH is of progression in patients diagnosed with glaucoma. Therefore, I note the low CH finding in the patient's chart, where I've already indicated a diagnosis of glaucoma. I want to watch this metric to see what happens.

I also find low CH very valuable when other factors point to glaucoma. Let's say, for example, that a patient has some optic nerve cupping without an overt notch in the rim. The patient has some mild diffuse retinal nerve fiber layer loss, but the OCT shows nothing definitive. Your findings suggest glaucoma, but you can't be certain enough to make a definitive diagnosis. I would look at the CH in such a patient. If it's significantly low, then I feel more confident that I have glaucoma on my hands. CH could be the factor that pushes the diagnosis over the edge.

Dr. Thimons: What I find is that CH may be able to identify rapid progressors, much as I found in the past when considering the difference between dynamic contour tonometry (DCT) and GAT.[20]

I anticipate that hysteresis will add yet another layer to this assessment, providing a much more relevant value than the difference between DCT and GAT. It will give me another reason to say, "That's a potential rapid progressor. I need to watch this patient more carefully."

Effect of Glaucoma Treatment on CH

Dr. Gaddie: What happens once you've diagnosed a patient with low CH and begun treating the patient for glaucoma? Does the therapy change the hysteresis of the cornea?

Dr. Bloomenstein: A few publications show CH increases after IOP reduction.[21-22] However, the studies I'm aware of have involved trabeculectomy and a significant change in IOP. For more routine pressure reductions, we may not have the definitive answer. I think this is an excellent example of what we don't know far outweighing what we know.

Dr. Thimons: Recent work by Agarwal[23] on CH and IOP response provides very interesting insight about predicting IOP response relative to CH values.

He showed that baseline CH measurements in newly diagnosed glaucoma patients were strongly predictive of the IOP response from prostaglandin analogues. He's at the beginning of a curve of information that I think we'll find incredibly valuable when managing our patients into the next decade.

Dr. Wooldridge: As we've discussed, until we had the results of the OHTS, we didn't know CCT was an independent risk factor. Now, I think we're just on the front end of the curve in terms of learning how valuable CH will be. I hope that practitioners in refractive and glaucoma care understand that we have a new parameter to use in evaluating our patients and consulting with them — parameter that will help us determine who does and doesn't need to be treated, and if treated, how aggressive the treatment.

Biomechanics and IOP

Dr. Gaddie: In the past, many clinicians wanted to adjust pressure based on pachymetry, but we now know this approach doesn't work. ORA helps clarify the clinical picture — not just by providing CH measurements, but by offering IOPg (Goldmann-correlated pressure) findings and IOPcc (corneal-compensated pressure) findings. In this context, we need to consider that IOPg and IOPcc are based on biomechanics derived partly from CH, not adjusted based on central thickness. In fact, as Dr. Thimons mentioned earlier, the IOPcc has essentially no correlation with CCT.

In our practice, the ORA is now the overall method by which we evaluate IOP. What are the approximations you arrive at when you use this measurement in your practices? How well does the IOPg correlate with actual Goldmann readings?

Dr. Wooldridge: I find that IOPg correlates very well. I'm fascinated to see the IOPg and actual Goldmann readings correlate when the IOPcc value doesn't correlate with the actual Goldmann reading. Discerning this difference gives me greater confidence that the ORA provides a measurement I might anticipate from a Goldmann, but also indicates when patients are probably much different than I would expect based on Goldmann alone. As we've been discussing, this is because the ORA isn't influenced by corneal effects influencing GAT. The ORA offers the benefit of seeing a significant difference between IOPg and IOPcc.

Dr. Thimons: I agree with Dr. Wooldridge wholeheartedly. Since I started using the ORA, I've looked at patients participating in my ongoing Pascal-Goldmann study. When comparing IOPg to IOPcc in these patients, I've been able to identify individuals who have the most aggressive glaucoma by distinguishing differences between those two values.

Dr. Bloomenstein: We see high correlations involving IOPg, IOPcc and GAT IOP values. I agree that we should attribute differences between GAT and IOPcc readings to corneal biomechanics, not corneal thickness. Corneal thickness is independent of CH and not a good IOP correction factor.

Patient Scenarios

Dr. Gaddie: Imagine that we have a patient who has a thick cornea, measuring 610 µm and a GAT reading of 20 mm Hg. The IOPg provided by the ORA might be 21 mm Hg, but you would predict a lower IOPcc based on the thick cornea. However, I consistently see patients who have thick corneas and elevated IOPcc levels that are actually higher than both the IOP measured by GAT and the IOPg measured by the ORA. What does that tell us?

Dr. Wooldridge: I've seen this phenomenon in many cases, and in both directions, by the way. At times, the IOPcc might be lower — not higher — than GAT and IOPg. I've seen these tendencies not only when using the ORA but also with the Pascal (DCT).

So, don't conclude that a reading, as measured

ENSURING STERILITY

Dr. Thimons: There has been concern about tonometer tip sterility over the past 5 years. The Veteran Administration Medical Center Systems are using unit-dose tonometer tips for every patient, creating a one-time use and disposable system.

Others actually sterilize 40 or 50 tips a day to keep the system clean and non-communicable. These steps are primarily used to prevent viral disease. The ORA system works exceptionally well to reduce contamination because it doesn't make contact with the eye.

Precision is also important. Goldmann tonometry is a somewhat riskier test when administered by a technician, student or anyone other than a trained clinician.

To record a measurement that I can rely on — much like the objective measurements recorded by an autorefractor — is tremendously helpful.

It takes a qualified technician time to perform GAT on general patients. If you repeat this 20 times a day, 100 times a week in a fairly busy practice, that is an enormous time savings to have general staff members able to generate accurate data, freeing the technician to participate in more complex office procedures. We also have to consider the costs of preps, wipes and tonometer tips. For the Pascal, cover tips and batteries must be included in the cost of operations. So, I think the use of ORA is most analogous to the auto kerato-refractometer. It's invaluable in a busy practice to have a system that's objective and can be operated by anyone.

by the ORA and DCT, is inaccurate because it's not what you expected based on corneal thickness. Such a conclusion shows just how inappropriate it is to do a corrected pressure based solely on corneal thickness. Finally, these situations again demonstrate the importance of corneal mechanics, not corneal thickness. Physiology is more important than anatomy.

Dr. Gaddie: The case you cite, Dr. Wooldridge, is a perfect example to consider: a patient with a thick cornea who also has a soft cornea.

Dr. Thimons: Yes, a patient with IOPcc that is lower than GAT and IOPg has weak biomechanics. Let me amplify Dr. Wooldridge's statement. Consider Frank Price's work on post-Descemet stripping endothelial keratoplasty (DSEK).[24]

The average corneal thickness was 700 µm because of the presence of additional graft tissue. Using normative assessment techniques from the OHTS, you would expect that the GAT would have easily measured the highest reading. However, pneumatonometry and DCT both produced markedly higher values than GAT, even though the cornea was thick. Pneumatonometry and DCT adjusted for the biomechanics and made the accurate measurement.

Dr. Price's general comment was that if GAT shows an elevated IOP after DSEK, you should be concerned and take action. That reading would be extraordinarily high if you used pneumatonometry or DCT. We certainly see this in our DSEK population. I don't bother with GAT anymore when evaluating these patients.

Long-term Glaucoma Patients

Dr. Gaddie: Another important issue arises when a patient progresses despite your best efforts. His GAT values indicate that his pressure is under control. You test him with an ORA, which shows that his CH is 4 or 5.

Could the CH reading be an indication of why the patient is progressing? Here's a correlate case: one of my patients started with a pressure of 35 mm Hg. I began treating him in 1999 and he really hasn't progressed. I checked his CH and found that it was 12, a reading that provided me with assurance. These are two cases that emphasize the value of retrospective analysis. Are any of you doing this to get a better handle on what is going on with your patients?

Dr. Thimons: We have used the ORA for the first time on about 200 glaucoma patients that have been in the practice under standard management. In that group, I'm pleasantly surprised by by the results, and certainly by the consistency of its predictive value. I've even looked at marginally progressive patients and those who started as severe ocular hypertensives whom we have managed down to 12 mm Hg or 13 mm Hg.

> "I've found that CH is predictive of which patients with ocular hypertension are more likely to convert to glaucoma. Also, those patients who have been diagnosed with glaucoma and have low hysteresis are more likely to be quick progressors. I've found CH to be remarkably predictive of both of those situations."
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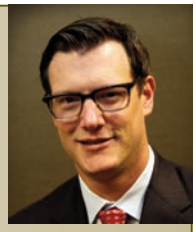

Have our ORA findings caused me to markedly change their medications? Not yet, but I anticipate this will probably will be one of the outcomes.

I had a 44-year-old patient with a CH of 3.4; we thought it was normal-tension glaucoma. She has undergone laser treatment and is certainly going to require a shunt much sooner than many other patients, regardless of what her pressures show. The CH helped us understand why she was progressing so quickly with a pressure of 11 mm Hg. Obviously, our measurements were just inaccurate.

Dr. Wooldridge: What was her IOPcc with the ORA?

Dr. Thimons: It was 19 mm Hg, almost 80% higher than with GAT. That was a very clear indicator.

A Place in Every Practice

Dr. Bloomenstein: Dr. Thimons, you've just demonstrated why the ORA has a place in every opto-

What Does Normal-Tension Glaucoma Really Mean?

Dr. Gaddie: As we look closely at corneal biomechanics to assess risk of glaucoma, we must ask if normal-tension glaucoma is an adequate term. Is there a mechanism involved in this disease that is independent of pressure?

Dr. Wooldridge: Clearly some patients have damage with normal pressure, so I don't want to discount pressure as a factor. However, I agree that a significant measurement artifact is involved in some cases. For some time now, I've measured patients' pressures with the Pascal Dynamic Contour Tonometer and the Reichert Ocular Response Analyzer (ORA) as well as with Goldmann applanation tonometry (GAT). I routinely get a range of pressures, spread across six or seven points.

Interestingly, some patients' pressures are very similar with all instruments and others have significant differences. When looking for a patient's true pressure, I might find readings of 16 mm Hg, 19 mm Hg and 25 mm Hg. It's obvious that we don't really know the pressure in some of these patients. So, yes, I think some normal-tension glaucoma patients are classified with this diagnosis based on measurement artifact. But we clearly have some glaucoma patients whose pressure is in the range, no matter how we measure it.

Dr. Thimons: I've been looking at the relationship between GAT and ORA in normal-tension patients in my practice, having preliminary data on 12 patients in this diagnostic category to date. Consistently, what I'm finding is that the ORA corneal-compensated IOP is considerably higher and, in most cases, is actually above 21 mm Hg. Therefore, the IOP we find through GAT may not truly reflect pressure levels in these patients. This new information from ORA may help in understanding possible pathophysiologic mechanisms that underlie this form of glaucoma.

metric practice. As I just said, we don't know what we don't know. Having more information makes the picture that much clearer for us and our patients.

Why are we checking pressure? Because it's the standard of care and we're trying to assign to patients the risk of having or developing glaucoma. Fortunately, glaucoma is a very slow and insidious disease. Nonetheless, I think most of us would rather start treatment to lower the pressure on a questionable patient than wait for damage to develop, then wish we had initiated treatment sooner. To me, the ORA provides that extra piece of the puzzle to help me make a diagnostic decision for the patient who has high pressure but otherwise normal examination findings and test results.

Being able to look at the ORA is very important to me. A normal CH value provides a peace of mind, sometimes determining if a patient should be brought back as a suspect or if the patient should be treated. Conversely, a patient whose pressures seems to be average but who shows suspicious findings on a visual field or frequency doubling technology scan can benefit from an evaluation with an ORA. If the hysteresis value is low, I know I need to watch the patient a little more closely.

Using the ORA Exclusively?

Dr. Bloomenstein: We use the ORA almost exclusively now. What's interesting is that, at its core, the technology is essentially a noncontact tonometer. When I talk to colleagues, they sometimes say, "Well, isn't that kind of moving backward? Going back to the puff test?" But this is not the old mom-and-pop, noncontact tonometer. The air puff is gentler and patients don't have that jump-back reaction we used to see. We're observing a tremendous amount of correlation between measuring Goldmann and using the IOPg, yet that value is flawed without knowing the CH and getting a more accurate pressure reading, such as the IOPcc.

Dr. Wooldridge: We routinely use the ORA, in addition to Goldmann tonometry, when assessing glaucoma patients and glaucoma suspects. This represents a paradigm shift for me because I didn't have much faith in the old noncontact tonometers. However, we now have tremendous confidence in the ORA. This is a new-generation instrument, involving an approach that is significantly different from the approach we took 25 years ago.

Getting a good reading on most patients with the ORA is easy — even those difficult patients known to be squeezers. Anyone in your practice can perform this test with adequate training. I'm very confident in the ability of my assistants to get an accurate measurement with the ORA. I'm much more confident delegating this test than delegating GAT.

Dr. Gaddie: Well, this is certainly not your grandfather's noncontact tonometer. I'd been

telling my patients for years that using NCT is not a good way to manage glaucoma. Now I'm saying, "Well, because of changes in technology, this is actually the most sophisticated method of measuring pressure in patients who have glaucoma." It just takes a little education.

Not only is it sophisticated in terms of the metrics that it provides, but it's also a more gentle administration of the air puff. Patients don't jump back like they did when we administered the older NCT. I've encountered very few complaints when using it.

Beyond Tonometry

Dr. Wooldridge: We need to think of the ORA as being more than just a tonometer. This instrument provides information that goes far beyond the corrected pressure in the eye. The data tells us something about the basic biomechanics of the cornea as it relates to glaucoma progression and other issues.

Dr. Thimons: This is a very relevant instrument for clinical practitioners because it provides a double value for your measurement. You're getting a glaucoma assessment, critical in a screening population, and you're also screening for a very important future disease — keratoconus. I think the device identifies at-risk patients very well. If the patient has a lower CH, that finding warrants topography. I believe this system will become the replacement technology for everything we've done in this area in the past. ■

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